U.S. Department
of Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

MAY - 6 2005

400 Seventh Street, S.W.
Washington, D.C. 20590

DOT-E 14157

EXPIRATION DATE: March 31, 2007

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: Worthington Cylinders of Canada Corporation
Tilbury, Ontario, Canada
(U.S. Agent: Worthington Cylinder Corporation,
Columbus, Ohio)

2. PURPOSE AND LIMITATIONS:

a. This exemption authorizes the manufacture, mark, sale and use of non-DOT specification cylinders conforming in part with the DOT-3AA specification, for use in the transportation in commerce of certain nonflammable, non-liquefied compressed gases. This exemption provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein.

b. The safety analyses performed in development of this exemption only considered the hazards and risks associated with transportation in commerce. The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.

3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.

4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR §§ 173.301(a)(1), 173.301(a)(2) and 173.302a(a)(1) in that non-DOT specification cylinders are not authorized, except as prescribed herein.

NOTE: The holder of this exemption must secure and maintain a valid approval as a foreign manufacture under § 107.807 from the Associate Administrator for Hazardous Materials Safety.

5. BASIS: This exemption is based on the application of Worthington Cylinders of Canada Corporation dated January 8, 2005, and additional information dated April 5, 2005 submitted in accordance with § 107.105 and the public proceeding therein.

6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Material Description			
Proper Shipping Name	**Hazard Class/ Division**	**Identi-fication Number**	**Packing Group**
Nonflammable, non-liquefied gases authorized for DOT 3AA specification cylinders	2.2	As appro-priate	N/A

7. SAFETY CONTROL MEASURES:

a. PACKAGING - Packaging prescribed is a non-DOT specification, high strength steel cylinder made in accordance with Worthington Cylinders of Canada Corp. drawings on file with the Office of Hazardous Materials Exemptions and Approvals (OHMEA). Cylinders must be in accordance with the requirements for DOT Specification 3AA (§§ 178.35 and 178.37) except as follows:

§178.35(a) Compliance and lot definition.

(1) Compliance with the requirements of this exemption is required in all details.

(2) Lot definition. In this exemption, a "lot" means a group of cylinders successively produced and having the same:

(i) Size and configuration;

(ii) Specified material of construction;

(iii) Process of manufacture and heat treatment;

(iv) Equipment of manufacture and heat treatment;

(v) Conditions of time, temperature and atmosphere during heat treatment.
(vi) In no case may the lot size exceed 200 cylinders, but any cylinder processed for use in the required destructive testing need not be counted as being one of the 200.

§ 178.35(c) *Duties of inspector.*

(1) and (2) * * *

(3) Verify compliance of cylinders with the terms of this exemption.

(4) * * *

§ 178.35(e) Pressure relief devices and protection for valves and pressure relief devices.

(Add) Pressure relief devices must be in compliance with § 173.302a(b)(1).

§ 178.35(f) *Marking.*

Applies except that "DOT-E 14157" must replace "DOT-3AA" followed by the service pressure. Test pressure (e.g. "TP 5250") must be marked following or near the service pressure. The letters "TP" preceding the test pressure is optional.

§ 178.35(g) Inspector's Report.

The inspector's report must be revised to accommodate the above changes in requirements.

§ 178.37(a) *Type, size and service pressure.*

(1) Seamless cylinder with nominal outside diameter, minimum wall thickness, minimum base thickness, maximum water capacity as shown on Table 1 of the exemption application on file with the OHMEA and maximum service pressure of 3,450 psig.

(2) Does not apply.

§ 178.37(b) *Authorized steel.*

Only basic oxygen or electric furnace steel of uniform quality is authorized. Steel must be aluminum killed and made by a fine grain deoxidation practice. The steel analysis must be in conformance with the following:

CHEMICAL COMPOSITION IN WEIGHT PERCENT

Element	Ladle analyses	Check analyses Tolerance	
		Under	Over
Carbon	0.31/0.36	0.01	0.02
Manganese	0.60/0.90	0.03	0.03
Phosphorus	0.015 Max.	-	0.01
Sulfur	0.010 Max.	-	0.01
Silicon	0.15/0.35	0.02	0.03
Chromium	0.80/1.10	0.03	0.03
Molybdenum	0.15/0.25	0.01	0.01
Vanadium	0.07/0.10	0.01	0.01
Aluminum	0.05 Max.		

Note 1: Steel must be treated with calcium to provide the following J-K micro cleanliness rating per ASTM Standard E-45, Method D.

A (Sulfides)		B (Alumina)		C (Silicates)		D (Oxides)	
Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Certificate from the material manufacturer must certify that the material was calcium treated and must include in such certification the J-K micro cleanliness rating for each heat of steel.

§ 178.37(c) *Identification of material.*

Materials must be identified by any suitable method. Steel stamping of heat identification must not be made in any area that will eventually become the sidewall of the cylinder. Depth of stamping shall not encroach upon the minimum prescribed wall thickness of the cylinder.

§ 178.37(d) *Manufacture.*

(1) Cylinder shells must be of seamless construction manufactured by the deep drawing method with integrally formed heads and bottoms; dirt and scale to be removed as necessary to afford proper inspection; no fissure or other defect acceptable that is likely to weaken the

finished cylinder appreciably. The general surface finish shall not exceed a roughness of 250 r.m.s. individual irregularities such as draw marks, scratches, pits, etc. should be held to a minimum. If the cylinder is not originally free of such defects or does not meet the finish requirements, the surface may be machined or otherwise treated to eliminate these defects. Metal removal for any purpose other than removal of isolated defects and threading must be done prior to the hydrostatic test. The thickness of the treated areas must be measured and must not be less than the minimum prescribed thickness. Cylinder end contour must be hemispherical or ellipsoidal (axis ratio of 2:1) with concave side to pressure.

(2) Shape and thickness of the cylinder bottom and sidewall adjacent to the bottom must be such that failure during the cycle pressure test occurs in the sidewall of the cylinder. The thickness of the cylinder bottom must be no less than the cylinder sidewall thickness.

(3) Design qualifications: The design authorized herein and any significant change to this design must be qualified for production by performing the test specified below:

(i) Burst Test. Three cylinders must be hydrostatically burst without evidence of fragmentation. The rate of pressurization must not exceed 200 psi per second. Cylinders subjected to the burst test must withstand a pressure of at least 2.25 times the service pressure without failure. Failure must initiate in the sidewall in a longitudinal direction, and the cylinder must remain in one piece.

(ii) Flattening Test. Three cylinders must be flattened to eight times the wall thickness without cracking.

(iii) Cycle Test. Three cylinders must be cycle tested to destruction to an upper cyclic pressure of 1.5 times service pressure. The successive hydrostatic pressurizations from the lower cyclic pressure to the upper cyclic pressure must not exceed a rate of ten cycles per minute. Adequate recording instrumentation must be provided if equipment is to be left unattended for any period

of time. Lower cyclic pressure must not exceed 10 percent of the upper cyclic pressure. Cylinders must withstand at least 10,000 cyclic pressurizations without distortion or failure. The failure must occur in the sidewall and the failure mode must be leak before burst (LBB). At least one cylinder must be cycled using water as the pressurizing medium.

(iv) Flawed Burst Test. One cylinder must be cycle tested to destruction at a pressure of 1.25 times the service pressure. This test must be performed after three flaws (slots) are machined into the upper sidewall of the cylinder. The flaws must have a minimum length of 6t, minimum depth of 0.1t and be located at 120° intervals. The flaws must be introduced into the cylinder by a means that will not affect the mechanical or metallurgical properties of the cylinder. The failure mode must be LBB. Examination of the failed cylinder must show evidence of fatigue crack propagation prior to leakage.

In this exemption, "significant change" means a 10 percent or greater change in cylinder wall thickness, service pressure, or diameter; a 30 percent or greater change in water capacity of base thickness; any change in material; over a 100 percent increase in size of openings; or any change in the number openings.

§ 178.37(e) *Welding or brazing.*

Welding or brazing for any purpose is prohibited.

§ 178.37(f) Wall thickness.

(1) Does not apply.

(2) The minimum wall thickness must be such that the wall stress at the minimum specified test pressure does not exceed 67 percent of the minimum tensile strength of the steel as determined in § 178.37(f)(3). A wall stress of more than 90,500 psi is not permitted and in no case may the wall thickness be less than that specified in Table A.

(3) Calculation must be made by the formula:

$$S = P(1.3D^2 + 0.4d^2)/(D^2 - d^2)$$

where:

S = wall stress in pounds per square inch;
P = minimum test pressure of 3/2 of service pressure;
D = outside diameter in inches;
d = inside diameter in inches.

§ 178.37(g) *Heat treatment.*

* * *

(1) The completed cylinder must be uniformly heat-treated prior to test.

(2) Each cylinder must be heated and held above the upper critical temperature (Ac_3) for at least one hour per inch of thickness based on the maximum thickness of the cylinder and then quenched in a suitable liquid medium having a cooling rate not in excess of 80 percent of water. The steel temperature on quenching must be above the Ac_3 temperature but not higher than 1700 °F.

(3) After quenching, each cylinder must be reheated to a temperature below the transformation range but not less than 1000 °F, and must be held at this temperature for at least one hour per inch of thickness based on the maximum thickness of the cylinder. Each cylinder must then be air cooled.

§ 178.37(h) *Openings in cylinders and connections (valves, fuse plugs, etc.) for those openings.*

(1) Threads required, to be clean cut, even, without checks, and to gauge. Openings are permitted in the top head and centerline of the cylinder only.

(2) All openings must be circular and threaded. Straight threads must be used and must conform with the following:

(i) National Gas Straight Thread (NGS) type must conform with the requirements of Federal Standard H-28 (1978), Sections 7 and 9.

(ii) Unified Thread (UN) type must conform with the requirements of Federal Standard H-28 (1978), Section 2.

(iii) Controlled Radius Root Thread (UNJ) type must conform with the requirements of Federal Standard H-28 (1978), Section 4.

(iv) Other straight thread types conforming with ISO standards may be used provided that the requirements of paragraph (3) below are met.

(3) All straight threads must have at least 6 engaged threads, a tight fit, and a factor of safety in shear of at least 10 at the test pressure of the cylinder. Shear stress must be calculated by using the appropriate thread shear area in accordance with Federal Standard H-28 (1978), Appendix A5, Section 3. Gaskets are required to prevent leakage.

§ 178.37(i) *Hydrostatic test.*

* * *

(1) Applies except that water jacket method only is authorized.

(2) * * *

(3) * * *

(4) Each cylinder must be tested to at least 3/2 times marked service pressure.

§ 178.37(j) *Toughness and ductility tests.*

(1) Flattening Test. Between knife edges, wedge-shaped, 60-degree angle, rounded to ½ inch radius; test one cylinder taken at random out of each lot of 200 or less cylinders. Longitudinal axis of the cylinder must be at approximately a 90 degree angle to the knife edges.

(2) Impact Tests. For each lot of 200 or less cylinders, three subsize Charpy V-notch specimens must be taken from the lower sidewall of one heat treated test cylinder at approximately evenly spaced (120 degree) intervals and tested at -50 °C in accordance with ASTM E-23.

(3) Flawed Burst Test. For each lot of 200 or less

cylinders, one cylinder must be flawed and cycle tested as described in § 178.37(d)(3)(iv) of this exemption.

(4) Hardness examination. A hardness measurement must be performed on the cylindrical section of each cylinder after heat treatment.

§ 178.37(k) *Physical test and magnetic particle examination.*

* * *

(1) * * *

(2) * * *

(3) * * *

(4) Cracks Examination. All cylinders must be examined in accordance with ISO 9809-2:1999 or inspected by the wet magnetic particle method in accordance with ASTM E-709-85 before closing in and after heat treatment to detect the presence of quench cracks or other discontinuities.

§ 178.37(l) *Acceptable results of production tests and inspections.*

(1) Impact tests. The Charpy V-notch impact properties for the three specimens for each lot of cylinders must not be less than the values shown below at -50°C:

Size (mm)	Average value for acceptance 3 specimens	Minimum value 1 specimen only of the three	Lateral expansion	Percent fibrous fracture
10x4	53 J/cm^2 (12.0 ft.lbs.)	44 J/cm^2 (10.0 ft.lbs)	0.305 mm (0.012 inches)	50

(2) Flattening Test. Flattening required without cracking to eight times the wall thickness of the tested cylinder. Continue flattening until cracking occurs. Maximum degree of flattening attained without cracking and knife clearance must be entered on the inspector's report.

(3) Flawed Burst Test. The failure must originate in the cylinder sidewall and be by leakage before burst.

(4) Mechanical Tests.

(i) Tensile strength must not exceed 159,000 psi.

(ii) Elongation must be at least 16 percent for gauge length of 2 inches with a width not over 1.5 inches.

(5) Cracks Examination. Any cylinder found to have a quenching crack must be rejected and may not be requalified.

(6) Hardness Measurement. The tensile strength equivalent of the hardness number obtained may not be more than 159,000 psi; (HRC 34(Brinell 334)). When the results of a hardness test exceed the maximum permitted, two or more retests may be made: however, the hardness number obtained in each retest may not exceed the maximum permitted.

§ 178.37(m) *Leakage test and ultrasonic examination.*

(1) Leakage test is not required.

(2) After heat treatment, each cylinder must be inspected by the ultrasonic examination method of ISO 9809-2:1999 to detect the presence of quench cracks or other discontinuities.

§ 178.37(n) *Rejected cylinders from production testing.*

(1) Reheat treatment of cylinders rejected by the impact test is authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.

(2) Reheat treatment of cylinders rejected by the flattening test is authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.

(3) Reheat treatment of cylinders rejected by the flawed burst test is authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.

(4) Reheat treatment of cylinders rejected by the mechanical properties test is authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.

(5) Cylinders rejected by the magnetic particle or ultrasonic examination (wherein the defects are not quench cracks) may be reheat treated, subsequent thereto, acceptable cylinders must pass all prescribed tests.

(6) Reheat treatment of cylinders rejected by the hardness measurement is authorized; subsequent thereto, acceptable cylinders must pass all prescribed tests.

b. TESTING -

(1) Five year requalification - Each cylinder must be requalified for use every five years in accordance with § 180.209 as prescribed for DOT-3AA cylinders or by ultrasonic examination. Cylinders requalified after having been subjected to the action of fire, must be reported to OHMEA prior to being placed back in service.

(i) Hydrostatic pressure test - Each cylinder must be tested in accordance with § 180.205(g) except

(A) Each cylinder must be tested to at least 3/2 times the marked service pressure.

(B) A rejection elastic expansion (REE) limit must be developed as specified in CGA Pamphlet C-5.

(ii) Ultrasonic Examination - As an alternative, each cylinder may be requalified by ultrasonic examination (UE) in accordance with an approved DOT exemption and a retest facility that is authorized for UE of high strength (tensile strength equal or greater than 159,000 psi) cylinders.

(A) The retest results for the ultrasonic examination must be submitted to OHMEA annually.

(B) A cylinder that has been exposed to fire or to excessive heat (temperatures of 1000°F or greater) may not be retested by ultrasonic examination.

8. SPECIAL PROVISIONS:

a. The manufacturer of the cylinder covered by this exemption must retain the test reports required by this exemption indefinitely as long as the cylinders are authorized for use.

b. A copy of the Inspector's report for each of the first three lots produced must be submitted to the OHMEA prior to shipment.

c. A person who is not a holder of this exemption, but receives a package covered by this exemption, may reoffer it for transportation provided no modification or change is made to the package or its contents and it is offered for transportation in conformance with this exemption and the HMR.

d. Each packaging manufactured under the authority of this exemption must be either (1) marked with the name of the manufacturer and location (city and state) of the facility at which it is manufactured or (2) marked with a registration symbol designated by the Office of Hazardous Materials Exemptions and Approvals for a specific manufacturing facility.

e. A current copy of this exemption must be maintained at each facility where the package is manufactured under this exemption. It must be made available to a DOT representative upon request.

f. In accordance with the provisions of Paragraph (b) of § 173.22a, persons may use the packaging authorized by this exemption for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this exemption.

g. A current copy of this exemption must be maintained at each facility where the package is offered or reoffered for transportation.

h. These cylinders may not be used for carriage of any gas that would cause hydrogen embrittlement of the steel.
i. Filling limits specified in § 173.302a(b) are not

authorized. Under no circumstance are these cylinders to be filled to a pressure exceeding the marked service pressure at 21°C (70°F).

j. Transportation of oxygen by aircraft is only authorized when in accordance with § 172.102(c)(2), Special Provision A52 and § 175.85(h) and (i).

k. Cylinders intended for use as SCUBA cylinders must have the outer surface treated to protect the cylinder from damage due to a salt water environment.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle, rail freight, cargo vessel and cargo aircraft only (see restriction in paragraph 8(j) above).

10. MODAL REQUIREMENTS: A current copy of this exemption must be carried aboard each cargo vessel or aircraft used to transport packages covered by this exemption. The shipper must furnish a copy of this exemption to the air carrier before or at the time the shipment is tendered.

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

- All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
- Persons operating under the terms of this exemption must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this exemption must receive training on the requirements and conditions of this exemption in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this exemption, including display of its number, when this exemption has expired or is otherwise no longer in effect.

12. REPORTING REQUIREMENTS: Shipments or operations conducted under this exemption are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR §§ 171.15 - Immediate notice of certain hazardous materials incidents, and 171.16 - Detailed hazardous materials incident reports. In addition, the grantee(s) of this exemption must notify the Associate Administrator for Hazardous Materials Safety -- OHMEA, in writing, of any incident involving a package, shipment or operation conducted under terms of this exemption.

Issued in Washington, D.C.:

Robert A. McGuire
Associate Administrator for
Hazardous Materials Safety

6 2005
DATE

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Washington, D.C. 20590. Attention: DHM-31.

Copies of this exemption may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat.dot.gov/exemptions Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

PO: CWFreeman